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USPC **705/3**

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See application file for complete search history.

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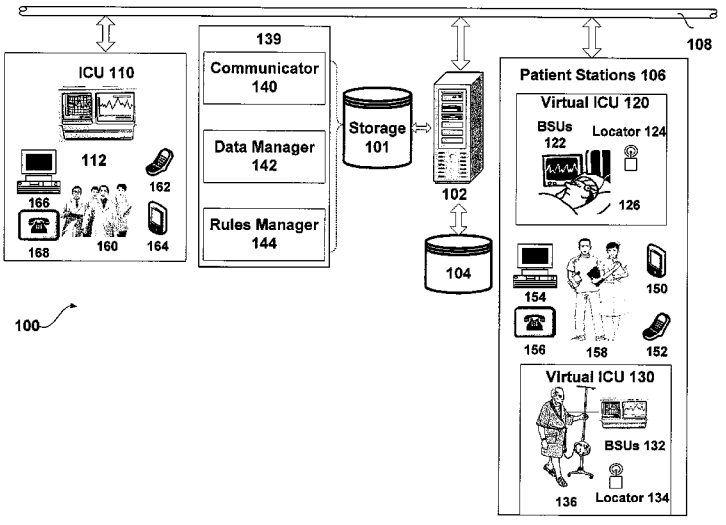
(57) **ABSTRACT**

Among other things, a computer implemented method for monitoring patients released from an intensive care unit in a healthcare environment is described. The method comprises receiving medical information of a patient located at a location different from the intensive care unit, evaluating conditions of the patient by applying one or more rules to the medical information of the patient, and sending a message to the intensive care unit when the conditions of the patient match the one or more rules.

30 Claims, 6 Drawing Sheets



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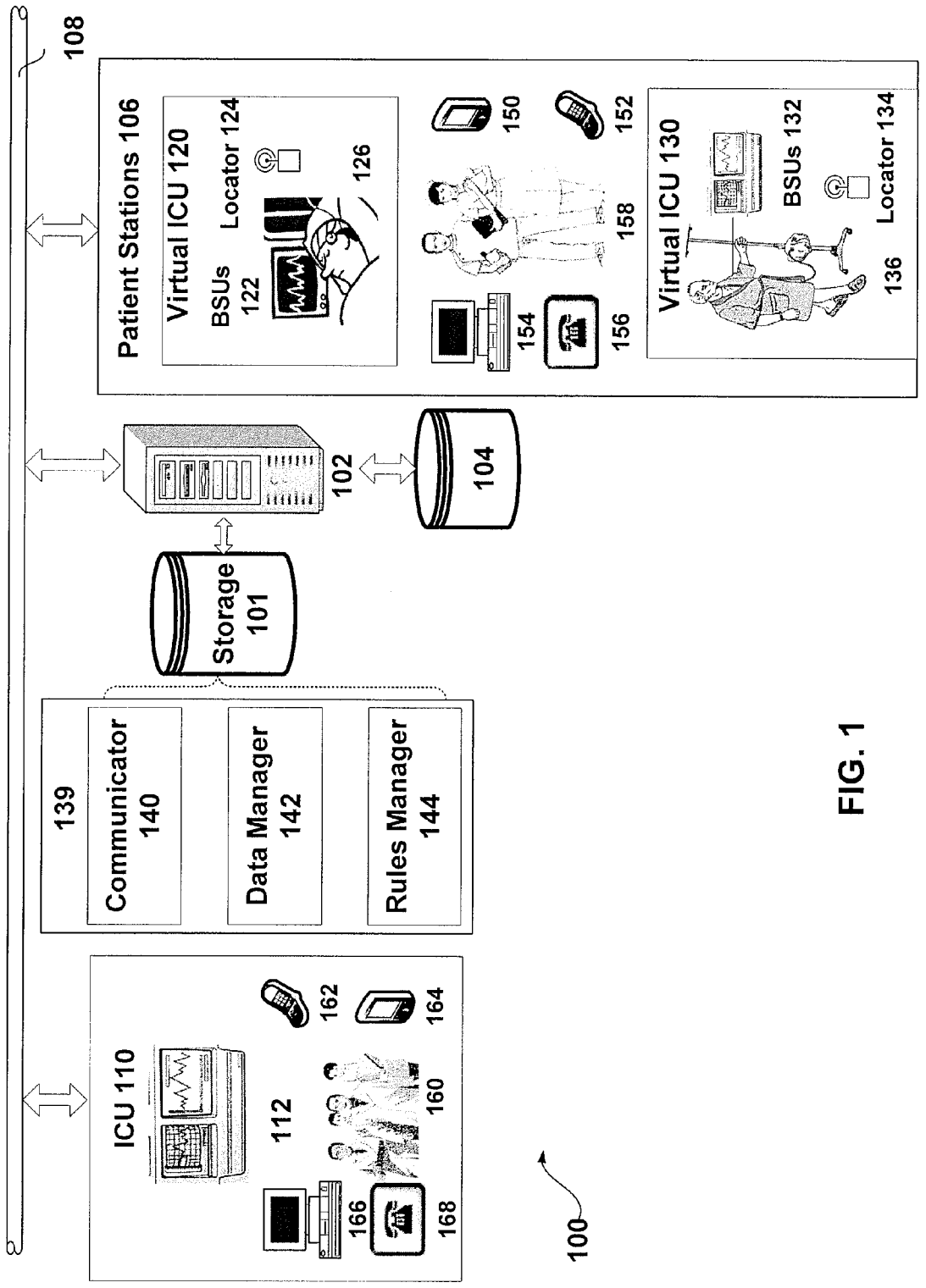
108
Patient Stations 106
Virtual ICU 120
BSUs 122
Locator 124
126
150
152
158
154
156
Virtual ICU 130
BSUs 132
Locator 134
136
102
104
Storage 101
139
Communicator 140
Data Manager 142
Rules Manager 144
ICU 110
112
160
162
164
166
168
100

FIG. 1

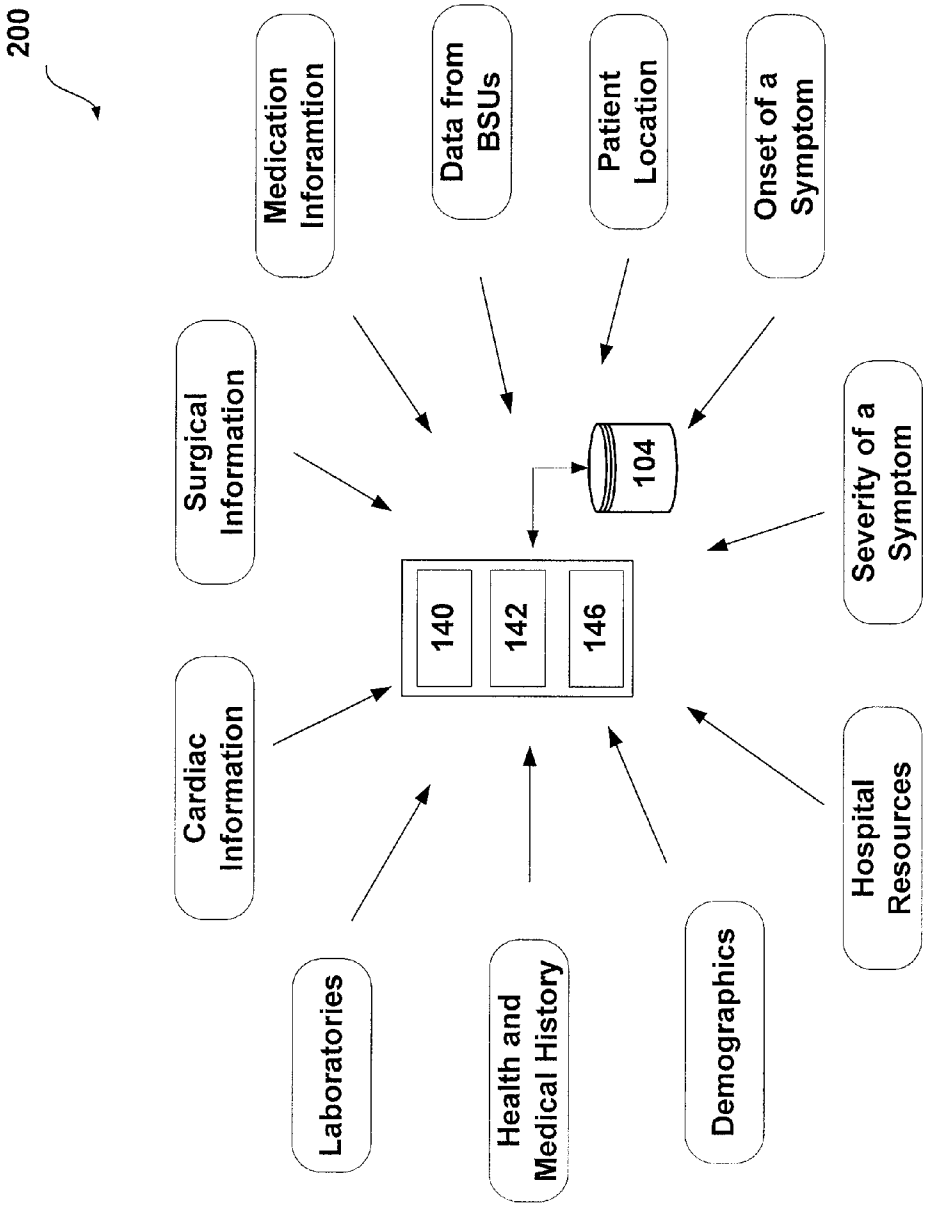
200
Medication Inforamtion
Data from BSUs
Patient Location
Onset of a Symptom
Surgical Information
Severity of a Symptom
104
140
142
146
Cardiac Information
Hospital Resources
Laboratories
Health and Medical History
Demographics

FIG. 2

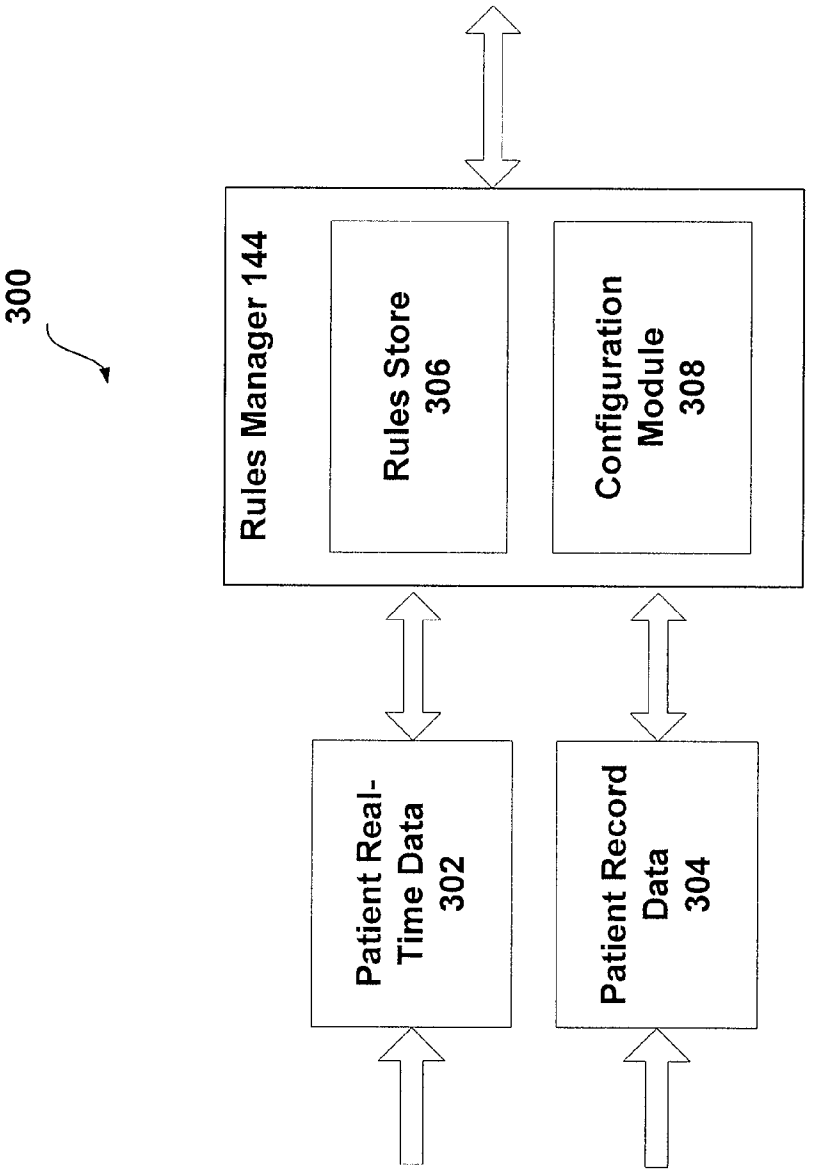
300
Rules Manager 144
Rules Store 306
Configuration Module 308
Patient Real-Time Data 302
Patient Record Data 304

FIG. 3

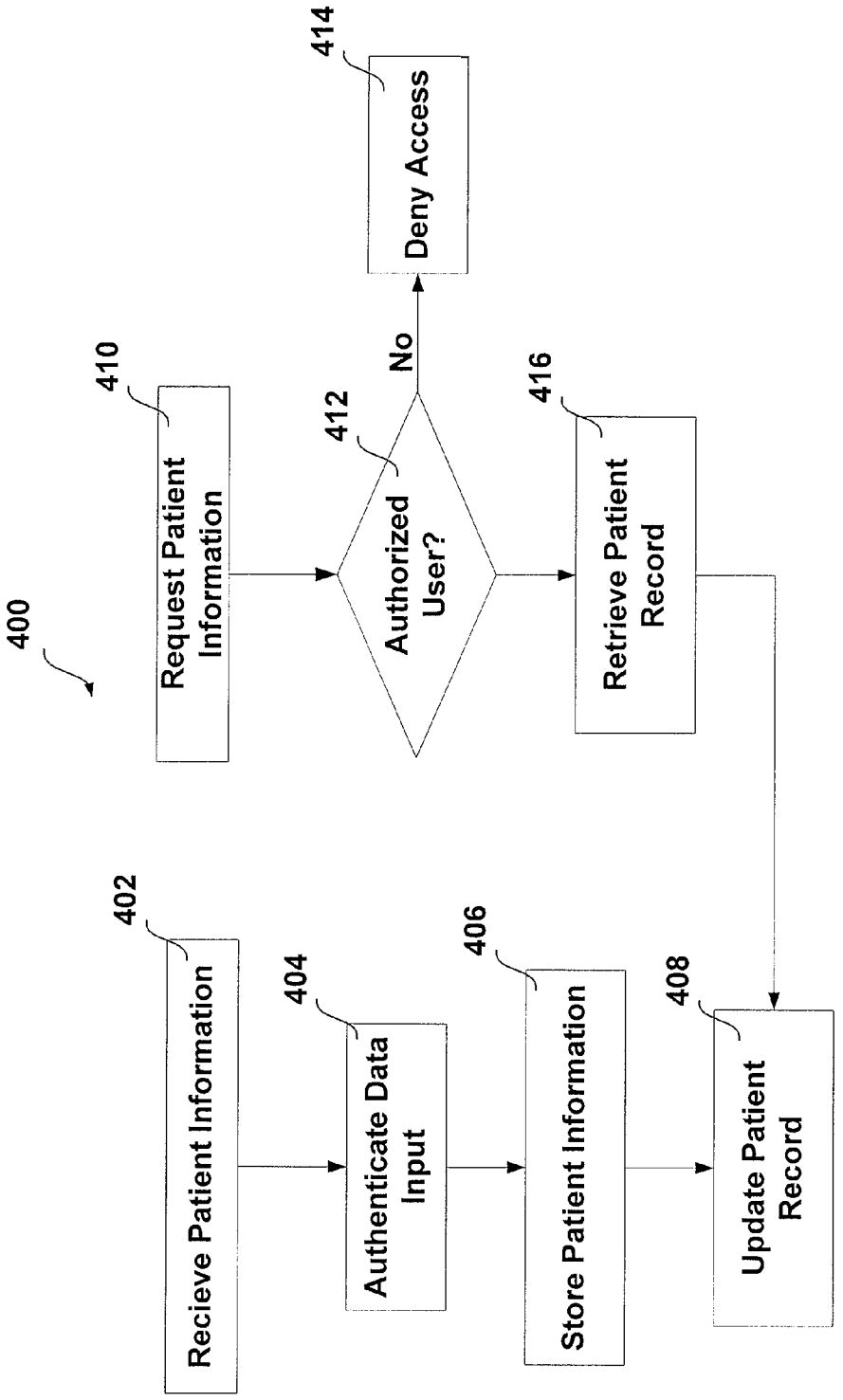
400
402
Recieve Patient Information
404
Authenticate Data Input
406
Store Patient Information
408
Update Patient Record
410
Request Patient Information
412
Authorized User?
No
414
Deny Access
416
Retrieve Patient Record

FIG. 4

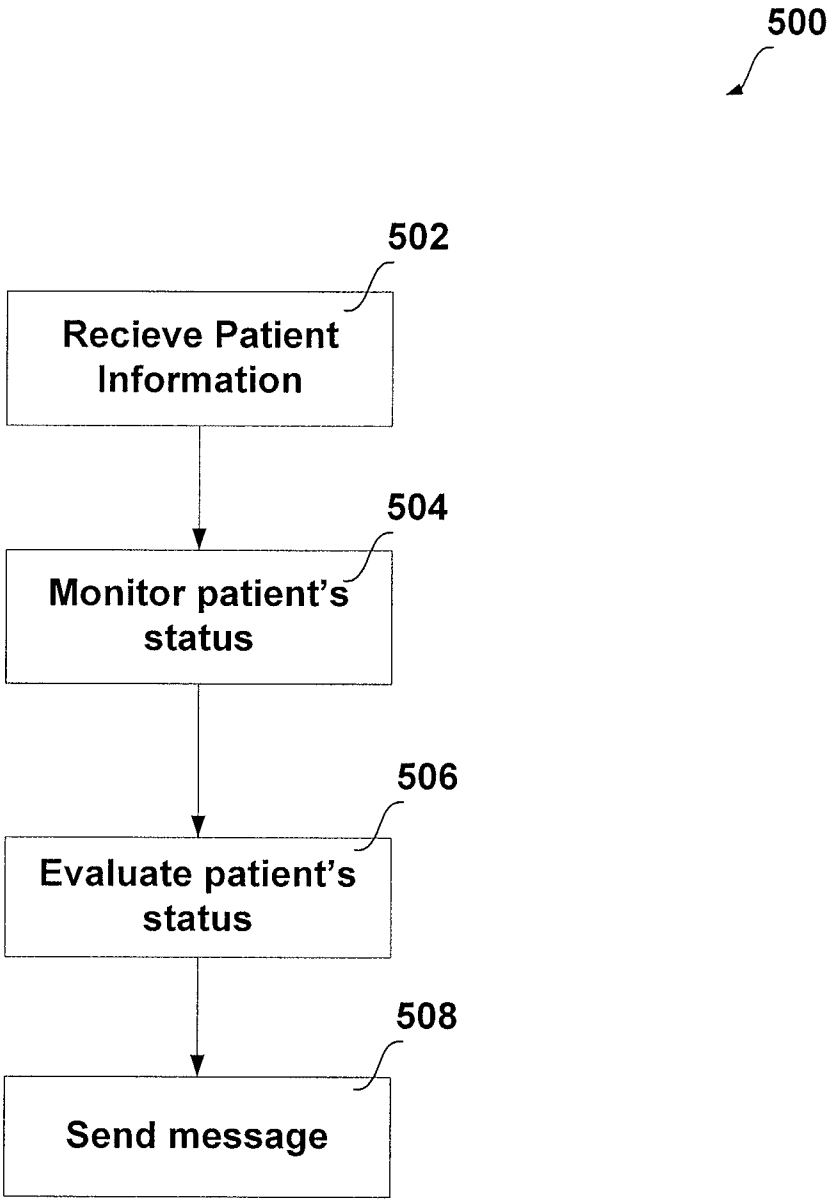
500
502
Recieve Patient Information
504
Monitor patient's status
506
Evaluate patient's status
508
Send message

FIG. 5

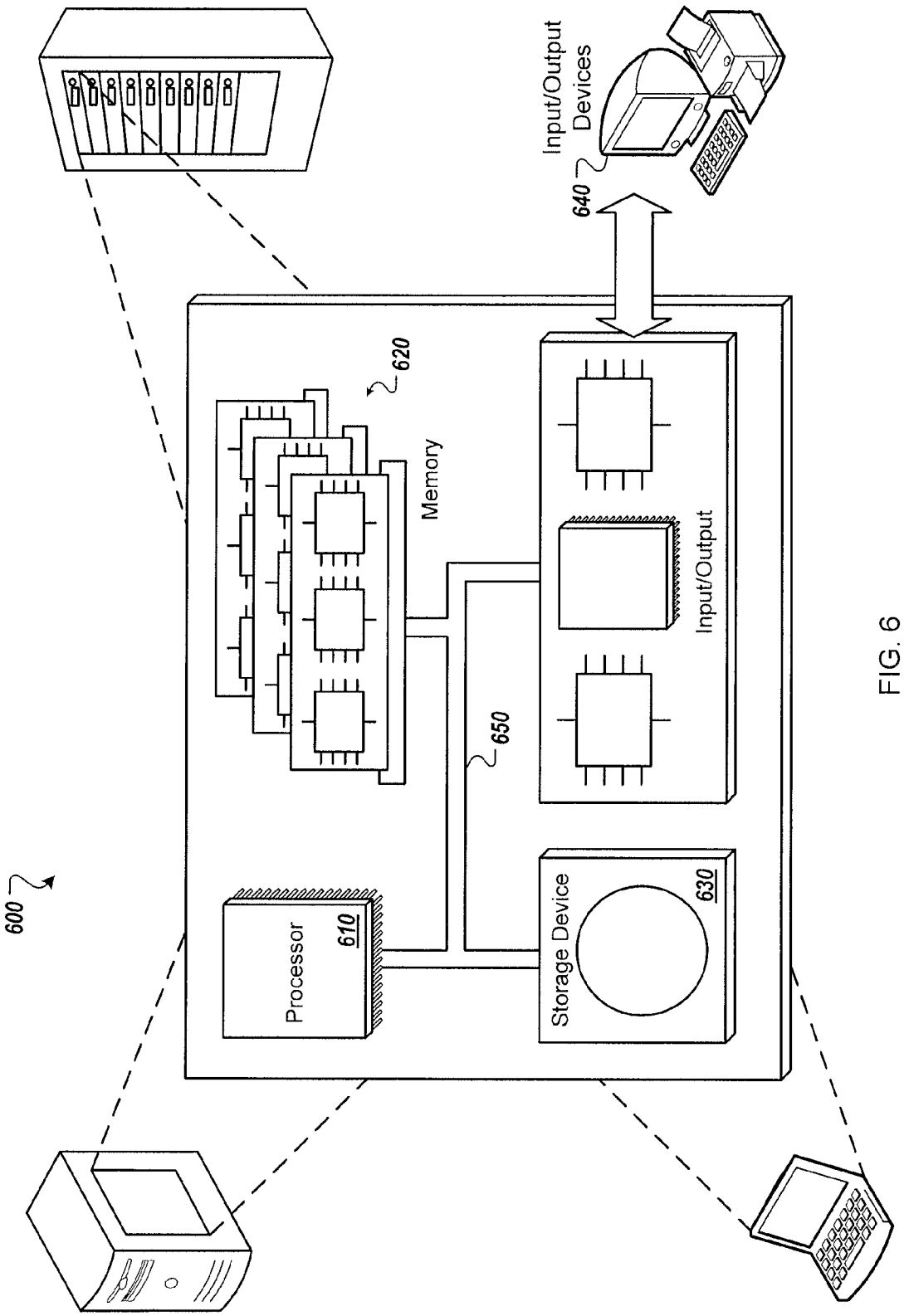
Input/Output Devices
640
620
Memory
650
Input/Output
600
Processor
610
Storage Device
630

FIG. 6

MONITORING PATIENT CONDITIONS

CROSS REFERENCE TO RELATED APPLICATIONS

Pursuant to 35 USC §119(e), this application claims the benefit of prior U.S. Provisional Application 61/092,527, filed Aug. 28, 2008. The application is incorporated by reference in its entirety.

BACKGROUND

This description relates to monitoring patient conditions to provide intensive care services within and external to intensive care units.

Medical monitoring equipment is located in a variety of healthcare facilities. One facility that may contain such equipment can be an intensive care unit (ICU) that allows patients in critical condition to be monitored. In general, an ICU is a specialized section of a healthcare facility (e.g., a hospital) and is equipped with the state-of-the-art electronic medical devices and a dedicated medical staff so that comprehensive and continuous care can be provided to patients with potentially life-threatening conditions. The use of the medical equipment in the ICUs can incur significant financial costs and the maintenance of the equipment may similarly call for significant fees.

SUMMARY

In general, in one aspect, a computer implemented method for monitoring patients released from an intensive care unit in a healthcare environment is described. The method comprises receiving medical information of a patient located at a location different from the intensive care unit, evaluating conditions of the patient by applying one or more rules to the medical information of the patient, and sending a message to the intensive care unit when the conditions of the patient match the one or more rules.

Implementations may include one or more of the following features. The patient at the location is monitored using a clinical medical device. The patient's location is determined using an electronic device. The electronic device is integrated with a device collecting the medical information of the patient at the location. The electronic device comprises a portable electronic device. Medical information of the patient is stored in a centralized data repository; and providing users at the intensive care unit with access to the centralized data repository. A user is authenticated when the user requests to access the centralized data repository. The medical information of the patient is updated in the centralized data repository. The one or more rules in connection with the medical information are updated. Treatment recommendations are provided to users at the location or at the intensive care unit. The conditions of the patient are displayed in the intensive care unit continuously.

In general, in another aspect, a computer-readable medium for storing instructions that are executable by a computer is described. The execution of the instructions causes the computer to receive medical information of a patient located in at a location different from an intensive care unit, evaluate conditions of the patient by applying one or more rules to the patient information of the patient, and send a message to the intensive care unit when the conditions of the patient match the one or more of the rules.

Implementations may include one or more of the following features. The computer monitors the patient at the location using a clinical medical device. The computer to determines the patient's location using a electronic device. The electronic device is integrated with a device collecting the medical information of the patient at the location. The electronic device comprises a portable electronic device. The computer stores medical information of the patient in a centralized data repository and provided users at the intensive care unit with access to the centralized data repository. The computer authenticates a user when the user requests to access the centralized data repository. The computer updates the medical information of the patient in the centralized data repository and updates the one or more rules in connection with the medical information. The computer provides treatment recommendations to users at the location or at the intensive care unit. The computer displays the conditions of the patient in the intensive care unit continuously.

In general, in another aspect, a system comprises a computing device comprising a memory and an engine. The engine is for receiving medical information of a patient located at a location different from an intensive care unit, evaluating conditions of the patient by applying one or more rules to the medical information of the patient, and sending a message to the intensive care unit when the conditions of the patient match the one or more rules.

Implementations may include one or more of the following features. The medical information is obtained by monitoring the patient at the location using a clinical medical device. The medical information comprises information about the patient's location determined by an electronic device. The electronic device is integrated with a device collecting the medical information of the patient at the location. The electronic device comprises a portable electronic device. The memory comprises a centralized data repository for storing medical information of the patient and the computer provides users at the intensive care unit with access to the centralized data repository. The computer authenticates a user when the user requests to access the centralized data repository. The engine updates the medical information of the patient in the centralized data repository and the one or more rules in connection with the medical information. The engine is configured to provide treatment recommendations to users at the location or at the intensive care unit. Conditions of the patient is displayed by a display in the intensive care unit continuously.

The details of one or more examples are set forth in the accompanying drawings and the description below. Further features, aspects, and advantages are apparent in the description, the drawings, and the claims.

DESCRIPTION OF DRAWINGS

FIG. **1** illustrates an exemplary monitoring system for a network-integrated intensive care unit (NI-ICU).

FIG. **2** illustrates exemplary types of information collected and maintained by a monitoring system for an NI-ICU.

FIG. **3** is illustrates processes executed by a monitoring system for an NI-ICU.

FIG. **4** is a flow chart of operations of a data manager software in a monitoring system for an NI-ICU.

FIG. **5** is a flow chart of operations of a rules manger software in a monitoring system for an NI-ICU.

FIG. **6** shows a schematic diagram of an example computer system.

DETAILED DESCRIPTION

Referring to FIG. **1**, a medical information system **100** includes one or more computer devices, such as general-

purpose personal computers, personal digital assistants, specialized computing devices, or reading machines. The computer devices collect various types of medical information at multiple locations (e.g., patient locations) and exchange the collected information over a shared network **108**. The medical information can be processed by manager software stored on a patient specific rules engine **144**, and can be displayed at an ICU station **110** of a healthcare facility. In this arrangement, some patients (e.g., patient **126**) that are considered relatively healthy may be released from the ICU station **110** and are remotely monitored by medical professionals **160** at the ICU station **110**. Medical information (e.g., monitoring equipment readouts) of these patients may be collected, for example, in real time and processed by a patient specific rules engine **144** and other associated software. Patient conditions may be monitored and identified as needed, and messages (e.g., alert messages) may be sent to medical professionals **160**, **158** located proximate or external to the ICU station **110** to act on the conditions of the patient **126** (e.g., a message is issued to prompt intervention).

By allowing medical information to be collected from sites external to the ICU station **110**, a network-integrated healthcare facility is produced. Through such a network, resources, e.g., equipment and medical professionals **160**, at the ICU are efficient used and conserved. Cost of care for patients (e.g., patient **126**) and equipment related cost may be reduced. In one arrangement, the ICU station **110** can be located within a healthcare facility (e.g., a hospital) and external patient stations **106** (e.g., to which the patient **126** is moved) may be linked to the ICU station **110** within the medical information system **100**. The healthcare professionals **160** at the ICU station **110** can monitor patients released from the ICU station **110** independent of the patients' current locations. Effectively, virtual ICUs **120**, **130** are generated in the patient stations **106** external to the ICU **110**. Through connections via the network **108**, the ICU **110** and the virtual ICUs **120**, **130** may be considered to have formed an NI-ICU system. More ICUs or virtual ICUs (not shown) can be included in the NI-ICU system. One or more NI-ICU systems may also be generated within the hospital. In each ICU or virtual ICU of the NI-ICU system, one or more patients may be connected to a variety of clinical devices within bedside units (BSUs) **122**, **132** that collect measurement data, e.g., in real time, from the respective patient or patients. Examples of the clinical devices include respirators, blood pressure monitoring device, electrocardiographs, or other suitable devices. Various operations may be executed upon the collected data, for example, patient data collected by the clinical devices can be stored in one or more data structures (e.g., a database) for examination and/or later use. Numerous techniques and methodologies may be implemented to collect, process and distribute the medical information represented by the patient data.

The BSUs **122**, **132** can also receive input by the medical professionals **160**, **158** and display the input. For example, the input can be associated with observations, notes, orders, and the like. Each clinical device of the BSUs **122**, **132** can be connected with a display system, e.g., including a universal interface device for facilitating information input and output. In one arrangement, the universal interface device is an RS-232 interface.

In some implementations, an operating system, such as Microsoft Windows®, is implemented in the BSUs **122**, **132** to provide a user-friendly interface for a user to access and input or retrieve patient medical information. Patients in each NI-ICU (e.g., located in an ICU or virtual ICU of the NI-ICU system) may equipped with locators (e.g., locators **124**, **134**). In some instances the locators may be positioned on structures associated with the location of the patients (e.g., wall mounted). The locators may provide real-time geographic information of the patient **126**, **136**, e.g., the hospital ward, examination room, floor or wing that the patient is presently located, to the BSUs **122**, **132**, and the ICU **110**, virtual ICUs **120**, **130**. The patient locators **124**, **134** may be integrated into the BSUs **122**, **132**, respectively, or installed separately as portable devices for the patient to carry around inside or outside a hospital.

The NI-ICUs **110**, **120**, **130** and the devices, such as the locators **124**, **134** enables the patients at different recovery stages to have some freedom of movement. For example, a fully ambulatory patient equipped with a locator can be allowed to exercise, e.g., walk, within an area designated by a physician. Furthermore, the locators **124**, **134** also enable continuous monitoring of patients in transit, e.g., during which the patient is moved among different examining rooms. Various location tracking technologies can be used for monitoring patient location in real time (e.g., a portable electronic Global Positioning System (GPS) tracker.)

Patient information collected in each NI-ICU **120**, **130**, such as information from measurements in the BSUs and/or patient locations, may be saved locally in the BSUs or remotely in one or more central storage devices (not shown).

In some implementations, the network **108** can be a wired and/or wireless distributed computing network. The network **108** can transmit the patient information among the NI-ICU **120**, **130** and a computer system **102** (or a centralized server **102**). The centralized server **102** may include a storage **101** for storing a computer program product **139** to manage a NI-ICU system. In addition, the centralized server **102** can also include a database storage **104**, e.g., a computer storage medium, for example, magnetic or optical disk storage, or non-volatile semiconductor memory storage. The centralized server **102** can also provide an interface shared by multiple units in the healthcare facility (e.g., the hospital). Each NI-ICU **120**, **130** may continuously monitor the reliability of its link to the network **108** via a network interface. In the event of a network failure, patient medical information or data can be replicated at the server **102** and the local NI-ICUs to reduce the probability of losing information.

In one arrangement, the computer program product **139** may include instructions, such that when executed, the centralized server **102** performs functions of a communicator **140**. The communicator **140** operates, e.g., to specify a user communication protocol for the user's hardware, operating system, line configuration, etc. For example, the communicator **140** can specify an appropriate communication port, speed (baud rate), interrupt settings, modem type and control strings, dial prefix, pulse or tone, and call waiting/shut-off for a standard duplex communication of telephone/audio connection **156**, **168** (in the ICU **110**). The communicator **140** can maintain a reliable connection among the NI-ICUs **110**, **120**, **130**. In some arrangements, other types of wide bandwidth, high speed communication capabilities, e.g., wired and wireless (e.g., satellite communications), may be implemented in the NI-ICU system.

The centralized server **102** also includes a data manager software **142** that may provide different users the ability to manage the patient medical information and data stored on the database storage **104**. The data manager software **142** also allows users to process resources (e.g., information from equipment) and control equipment through multiple user logic views at different locations (e.g., different terminals). The data manager software **142** also allows users (e.g., authorized users) to access the database storage **104** e.g., to analyze

and update patient medical information and data. The data manager software **142** may also control and enforce database security by preventing unauthorized users from viewing, accessing and updating the database stored in the database storage **104**.

As will be described in more detail below in FIG. **3**, the centralized server **102** and the database storage **104** (also referred to as data repository **104**) store comprehensive patient records, results from measurements at the BSUs. The centralized server **102** can be configured to allow authorized users to access such information over a network, e.g., the network **108**. In some arrangements the server **102** may also channel information to authorized users. Because information associated with the patients and the hospital can be stored in a centralized fashion at the centralized server **102**, the medical information system **100** allows simultaneous monitoring and access to the information by multiple users.

In addition, the centralized server **102** also includes the rules manager software **144**. The rule manager software **144** evaluates the patient conditions, e.g., continuously, by applying one or more rules. In some implementations, the rules are applied based on the information stored in the centralized server **102** and database storage **104**. Implemented as a decision support module, the rules manager software **144** can search for and analyze patterns, values, trends, etc. of the information. The result of the search or analysis can be indicative of clinical deterioration or recovery of the patients and messages can be sent to the healthcare professions **160**, **158** (e.g., physicians, nurses, etc.). The messages can be sent to a variety of devices by one or more networks, e.g., the network **108**. The devices can include, for example, desktop computers **154**, **166**, a workstation, a laptop, personal digital assistants (PDAs) **150**, **164**, cell phones **152**, **162**, beepers, and other types of network enabled devices and programs, modules or components of such devices. In addition, the messages can also be sent to a console **112** of the ICU station **110**. U.S. Pat. No. 6,322,502, incorporated herein by reference in its entirety, describes a medical information system in which data from multiple BSUs is provided to a common database.

The medical team on duty, including the medical professionals **158** may monitor the patients in each NI-ICU and conduct routine medical services and practices. Patient information and physical location (e.g., current location) may also displayed and stored on computer terminals installed at doctor offices and nurse stations.

In some implementations, the centralized console **112** is installed at an ICU **110** to provide the medical personnel **160** with the ability to retrieve multiple step-down NI-ICU patients records from the centralized server **102** and the data depository **104** through the network **108**. Current conditions of one or more NI-ICU patients can be displayed, e.g., in an automatic manner and substantially in real-time, on the centralized console **112**. The medical professional **160** at the ICU **110** can integrate the data from a plurality of sources to make an informed diagnosis regarding a certain NI-ICU patient. For patient information periodically collected from each NI-ICU, data updates may occur during the review time of medical professional **160**. In some implementations, a message may automatically appear on the display screen of the console **112** to inform (e.g., alert) the professional that a particular data set has been updated.

Referring to FIG. **2**, the communicator **140**, the data manager software **142** and the rules manager software **144** that reside on centralized server **102**, and database storage **104** are capable of collecting and storing comprehensive patient records transmitted from one or more departments and devices in the healthcare facility (e.g., the hospital). In the illustrated example, the data manager software **142** (shown in FIG. **1**) supports organizing, searching, sharing, and synchronizing data along with providing security to the data that resides in the database storage **104**. The data management operations may be implemented, for example, based upon a relational data model. In some implementations, specific types of patient data are described in schemas in such a data model, and the data manager software **142** can conveniently and efficiently provide a mechanism to extend the set of schemas to include new types of data defined as subtypes of the corresponding basic type. Updates of the patient data are also monitored and tracked by the medical information system **100**. System **100** may also include an application programming interface (API), which enables various application programs to access the data described in the schemas.

In some implementations, a patient's demographics (e.g., patient's name, address, marital status, age, gender, and ethnicity), health and medical history (e.g., illness, allergies, and medications) can be accessed by all the authorized departments and staff of the hospital. Results of laboratory tests and diagnosis (e.g., radiology reports and microbiology reports), cardiac information, surgical information, and medication information may be accessed and updated by physicians or other staff at the hospital. To reduce human errors, the system **100** can provide customized input masks. For example, if a physician inputs patient data that is incorrect, e.g., being incompatible with default information or existing information stored in the system **100**, a message appears on a user interface to request the physician to check the input.

Each NI-ICU provides real time measurement data obtained from BSUs **122**, **132** (such as electrocardiograph (ECG) data, blood pressure data, pulse rate data, body temperature data, and patient locations) to the centralized data depository **104**. Patients and physicians in each NI-ICU **120**, **130** can also report abnormal conditions, such as an onset of a symptom, observed by either the patient or a physician. The severity of the symptom is recorded in order for the medical staff on duty in both the ICU station **110** and the patient station **106** to decide whether or not to take immediate action for the patient. Hospital resources may be maintained up-to-date, such that the medical team **160** of the ICU station **110** can order therapies and discuss patient care issues with available specialists and physicians and generate an appropriate treatment plan in a timely fashion.

Referring to FIG. **3**, the rules manager software **144** includes a rules repository that receives patient measurement data **302** (e.g., real time data) from one or more bedside monitors and patient record data **304** from the sever **102** and centralized database **104**. The rules repository contains a rules store **306** that supports general and complex decisions in diagnosis and a configuration module **308** that allows physicians to customize rules for one or more specific patients. For example, by comparing measured data (e.g., from the BSUs **122**, **132**) to one or more predefined values (e.g., thresholds), the condition of one or more patients may be analyzed by the rules manager software **144** in a continuous or periodic manner. When the condition of a patient deteriorates, e.g., based on results from hemodynamics and respiratory measures, a message (e.g., an alert) to appropriate medical staff may be triggered. The rules store **306** manages parameters, such as values of a threshold for monitoring patient conditions. The threshold can be chosen or determined based on theoretical or empirical data or information of the patient or other patients having similar medical conditions. Healthcare professionals may also generate rules by themselves based on patient con

ditions. For example, logical statements and parameters such as:

heart rate>120 bpm and temperature>100 degree

may be used in one or more rules in the rules store **306** or configured by the physicians. When the patient conditions satisfy the rules, a message, e.g., including a flag or an alert, may be delivered to ask the physicians to take appropriate actions.

A user interface, such as a graphical user interface (GUI), can be implemented to integrate with the communicator **140** to enable the users (e.g., doctors, nurses) to access, e.g., review and manipulate (e.g., create, delete and modify) the patient information. Such a GUI may also facilitate rule creation, e.g., by displaying to the users a rules template for default rules or threshold values. Some arrangements may provide a rule wizard for creating rules on a step-by step basis.

The rules manager software **144** stores rules that have been created. In some implementations, the name of a person who created the rule and the time the rule is created, the results of the application of the rule are also stored. Invalid or obsolete rules are purged out of the rules module **306** periodically. The rules module **306** can also be updated by authorized users, such as a database administrator. The rules manager software **144** proactively monitors system **100** to provide support to the medical professionals. As such, the system **100** can be configured and administered in accordance with dynamic situations of the patients and multiple departments of the hospital. The system **100** is supported by backups and can maintain and manage dynamic changes in the patient database. Performance of the system **100** can be analyzed and evaluated for adjustment of portions of the system **100**, e.g., to improve efficiency or accuracy of the medical care provided to different patients.

Referring to FIG. **4**, a flow chart **400** represents some operations of the data manager software **142** for dynamically maintaining patient information received from one or more sources of a healthcare environment. As mentioned above, the data manager software **142** collects and maintains comprehensive, patient-related information. In some arrangements, upon receiving (**402**) patient information through the network **108**, the data manager software **142** authenticates (**404**) data input through various mechanisms. In some embodiments, the sources, e.g., a lab or a department of a hospital, of the input data can be checked. For example, usernames, passwords, e.g., one-time passwords, or record biometrics information of the user, e.g., fingerprints, hand geometry, and voice can be checked. In some embodiments, the destinations of the input data can be examined. For example, results of the BSU measurements or patient location information may be reported to certain physicians or departments in a particular format. The authentication process can take the form of checking and confirming special verifiers (e.g., labels or serial numbers) previously assigned to certain devices (e.g., locators **124**, **134**, BSUs **122**, **132**). The authentication can also be performed within a particular time window by incorporating timestamps within protocol messages where authentication data is carried. Additionally, other types of information, such as clinical research study information, information related to patient symptoms and diseases, may also be provided to the data manager software **142** from various devices (e.g., a medical content integrated service). In order to enhance the integrity and consistency of system **100**, the patient information is categorized and stored (**406**) in the centralized server **102** and the data depository **104**.

In use, the users may need to request (**410**) specific patient information from the system **100**. The users can log into the system **100**, e.g., using usernames and passwords. In response to patient information request by healthcare professionals, e.g., **158**, **160**, the data manager software **142** automatically polls the server **102** and the data depository **104** and determines operations the requesting party is allowed to perform. For example, only doctors are permitted to access and enter information regarding prescriptions for drugs and treatment therapies; and only pharmacists are permitted to access and enter information related to the filling of prescriptions. Nurses and other medical staff are permitted to access and enter information with regards to administration of drugs and treatments. Similarly, user authentication (**412**) can be performed by various methods, as described above. Unauthorized users or hostile accessing attempts are denied (**414**) by the system **100**. In order to retrieve (**416**) desired patient records, the data manager software **142** checks or interprets the user request based upon medical knowledge, and subsequently applies appropriate algorithms to search for the records in the data depository **104**. Simultaneous editing of same set of patient data may be prohibited by the system **100** in order to maintain the consistency of the patient records. The patient records stored at various locations can be automatically updated **408** when the user updates the records at one of the locations.

The rules manager software **144** can calculate a score representing the severity of a patient's conditions according to user-specified rules. The patient's score reflects relationships between various factors. Each factor can be weighted according to its significance as defined in a formulae used for calculating the score. Members of authorized medical teams in the hospital can define and update the formulae for each patient. The physicians **160** in the ICU **110** can receive messages from the rules manager software **144**. Using the received messages and the diagnosis, the physicians can determine whether the treatment of a patient needs to be adjusted. For example, if a patient's complex shows abnormality or an acute condition, an emergency condition service moves the patient from a virtual ICU **120**, **130** of the NI-ICU system back to the ICU **110**. The resources of the hospital are then reallocated. For example, more devices and physicians can be added, the pharmacy department can be informed for medications, and the specialists can be called in. If the patient conditions become complicated due to persistent symptoms, a symptom assessment service will be launched to better assist the physicians to address the problem. For example, the rules manager software **144** can be adapted to guide the physicians **160** through a series of calculations based on the available patient data to reach a subjective conclusion. If a patient becomes observably healthier, the patient can be routinely examined on a periodic basis, and be discharged from the hospital. Therefore, the NI-ICU system in the hospital can continuously provide patients that have been released from an ICU with high quality and reliable medical services that are usually provided when the patients are in the ICU.

FIG. **5** is a flow chart **500** of exemplary operations of the rules manager software **144**. The instructions of the rules manager software **144** can be executed by a single computing device or by distributed multiple devices. The rules manager software **144** and modules associated with the software may be standalone programs. The rules manager software **144** receives (**502**) patient medical information collected from a wide variety of clinical devices. The rules manager software **144** monitors (**504**) the patient's current clinical data in real-time and checks the validity of certain rule or a set of rules defined for a specific patient in the virtual ICU of the NI-ICU system. The monitoring and checking may include searching, accessing and retrieving patient records stored in the central-

ized server **102** and data depository **104** for data comparison and updating. By continuously evaluating (**506**) patient information, the rules manager software **144** can detect abnormal symptoms or risk factors in the conditions of the patients in a timely fashion. In the event of a violation of a rule, The rules manager software **144** can send (**508**) a message, e.g., including an alert, to the centralized console **112**, such that the medical team **160** can take proper actions.

In some implementation, the location of the patient can be reported to relevant medical personnel and departments for appropriate medical care arrangement and scheduling. The rules manager software **144** may also be configured to recommend possible treatment procedures, e.g., at critical times, such that both the local medical team **158** in the virtual ICUs and the medical team **160** in the ICU **110** can work together. The physicians at different locations may collaborate on diagnosis and treatment plans through the communicator **140**.

The apparatus, methods, flow diagrams, and structure block diagrams described in this patent document can be implemented in computer processing systems including program code comprising program instructions that are executable by the computer processing system.

FIG. **6** is a schematic diagram of an example computer system **600**. The system **600** can be used for practicing operations described above. The system **600** can include a processor **610**, a memory **620**, a storage device **630**, and input/output devices **640**. Each of the components **610**, **620**, **630**, and **640** are interconnected using a system bus **650**. The processor **610** is capable of processing instructions within the system **600**. These instructions can implement one or more aspects of the systems, components and techniques described above. In some implementations, the processor **610** is a single-threaded processor. In other implementations, the processor **610** is a multi-threaded processor. The processor **610** can include multiple processing cores and is capable of processing instructions stored in the memory **620** or on the storage device **630** to display graphical information for a user interface on the input/output device **640**.

The memory **620** is a computer readable medium such as volatile or non volatile that stores information within the system **600**. The memory **620** can store processes related to various functionality, for example. The storage device **830** is capable of providing persistent storage for the system **600**. The storage device **630** can include a floppy disk device, a hard disk device, an optical disk device, or a tape device, or other suitable persistent storage mediums. The storage device **630** can store the various databases described above. The input/output device **640** provides input/output operations for the system **600**. The input/output device **640** can include a keyboard, a pointing device, and a display unit for displaying graphical user interfaces.

The computer system **600** illustrates one example of a computing device. In general, embodiments of the subject matter and the functional operations described in this specification can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this specification and their structural equivalents, or in combinations of one or more of them. Embodiments of the subject matter described in this specification can be implemented as one or more computer program products, i.e., one or more modules of computer program instructions encoded on a computer readable medium for execution by, or to control the operation of, data processing apparatus. The computer readable medium can be a machine-readable storage device, a machine-readable storage substrate, a memory device, or a combination of one or more of them. The term "data processing apparatus" encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, or a combination of one or more of them.

A computer program (also known as a program, software, software application, script, or code) can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form, including as a stand alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application specific integrated circuit).

Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read only memory or a random access memory or both. The essential elements of a computer are a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto optical disks, or optical disks. However, a computer need not have such devices. Moreover, a computer can be embedded in another device, e.g., a mobile telephone, a personal digital assistant (PDA), a mobile audio player, a Global Positioning System (GPS) receiver, to name just a few. Computer readable media suitable for storing computer program instructions and data include all forms of non volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto optical disks; and CD ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

To provide for interaction with a user, embodiments of the subject matter described in this specification can be implemented on a computer having a display device, e.g., a CRT (cathode ray tube) or LCD (liquid crystal display) monitor, for displaying information to the user and a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of

sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

Embodiments of the invention can be implemented in a computing system that includes a back-end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front-end component, e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation of the invention, or any combination of one or more such back-end, middleware, or front-end components. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network ("LAN") and a wide area network ("WAN"), e.g., the Internet.

The computing system can include clients and servers. A client and server are generally remote from each other and typically interact through a communication network. The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other.

While this specification contains many specifics, these should not be construed as limitations on the scope of the invention or of what may be claimed, but rather as descriptions of features specific to particular embodiments of the invention. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

This written description sets forth the best mode of the invention and provides examples to describe the invention and to enable a person of ordinary skill in the art to make and use the invention. This written description does not limit the invention to the precise terms set forth. Thus, while the invention has been described in detail with reference to the examples set forth above, those of ordinary skill in the art can effect alterations, modifications and variations to the examples without departing from the scope of the invention.

What is claimed:

1. A computer implemented method for monitoring patients comprising:

during a period of time, continuously monitoring patients released from an intensive care unit in a healthcare environment,

wherein the at least some of the released patients who are being continuously monitored are at a recovery stage between a first recovery stage of patients remaining at the intensive care unit and a second recovery stage of patients only needing periodic routine examination without continuous monitoring;

receiving medical information of a patient released from the intensive care unit and being continuously monitored;

evaluating conditions of the released patient on a computing device by applying one or more formula-generated patient specific rules to the medical information of the released patient; and

sending a message to a health care professional based on the evaluated conditions of the released patient, wherein the message prompts the health care professional to determine

whether to readmit the released patient to the intensive care unit in response to the evaluated conditions indicating the patient is in the first recovery stage or

whether to discontinue continuously monitoring the released patient in response to the evaluated conditions indicating the patient is in the second recovery stage that needs periodic routine examination without continuous monitoring.

2. The method of claim **1** further comprising monitoring the released patient using a clinical medical device.

3. The method of claim **1** further comprising determining a location of the released patient using an electronic device.

4. The method of claim **3** wherein the electronic device is integrated with a device collecting the medical information of the released patient at the location.

5. The method of claim **3** wherein the electronic device comprises a portable electronic device.

6. The method of claim **1** further comprising:

storing the medical information of the released patient in a centralized data repository; and

providing users at the intensive care unit with access to the centralized data repository.

7. The method of claim **6** further comprising authenticating a user when the user requests to access the centralized data repository.

8. The method of claim **6** further comprising:

updating the medical information of the released patient in the centralized data repository; and

updating the one or more rules in connection with the medical information.

9. The method of claim **1** comprising providing computer-generated treatment recommendations to at least one of a location of the released patient and the intensive care unit.

10. The method of claim **1** comprising displaying the conditions of the released patient in the intensive care unit continuously.

11. A computer-readable storage medium for storing instructions that are executable by a computer, the execution of the instructions causes the computer to:

for a period of time, continuously monitor patients released from an intensive care unit in a healthcare environment; wherein at least some of the released patients who are being continuously monitored are at a recovery stage between a first recovery stage of patients remaining at the intensive care unit and a second recovery stage of patients only needing periodic routine examination without continuous monitoring;

receive medical information of a patient released from the intensive care unit and being continuously monitored;

evaluate conditions of the released patient by applying one or more formula-generated patient specific rules to the patient information of the released patient; and

send a message to a health care professional based on the evaluated conditions of the released patient, wherein the message prompts the health care professional to determine

whether to readmit the released patient to the intensive care unit in response to the evaluated conditions indicating the patient is in the first recovery stage or

whether to discontinue continuously monitoring the released patient in response to the evaluated conditions indicating the patient is in the second recovery stage that needs periodic routine examination without continuous monitoring.

12. The computer-readable storage medium of claim **11** further comprising causing the computer to monitor the released patient using a clinical medical device.

13. The computer-readable storage medium of claim **11** further comprising causing the computer to determine a location of the released patient using an electronic device.

14. The computer-readable storage medium of claim **13** wherein the electronic device is integrated with a device collecting the medical information of the released patient at the location.

15. The computer-readable storage medium of claim **13** wherein the electronic device comprises a portable electronic device.

16. The computer-readable storage medium of claim **11** further comprising causing the computer to:

store the medical information of the released patient in a centralized data repository; and

provide users at the intensive care unit with access to the centralized data repository.

17. The computer-readable storage medium of claim **16** further comprising causing the computer to authenticate a user when the user requests to access the centralized data repository.

18. The computer-readable storage medium of claim **16** further comprising causing the computer to:

update the medical information of the released patient in the centralized data repository; and

update the one or more rules in connection with the medical information.

19. The computer-readable storage medium of claim **11** comprising providing computer-generated treatment recommendations to at least one of a location of the released patient and the intensive care unit.

20. The computer-readable storage medium of claim **11** comprising displaying the conditions of the released patient in the intensive care unit continuously.

21. A system comprising:

a computing device comprising

a memory; and

an engine configured to

continuously monitor patients released from an intensive care unit in a healthcare environment for a period of time, wherein at least some of the released patients who are being continuously monitored are at a recovery stage between a first recovery stage of patients remaining at the intensive care unit and a second recovery stage of patients only needing periodic routine examination without continuous monitoring;

receive medical information of a patient released from the intensive care unit and being continuously monitored,

evaluate conditions of the released patient by applying one or more formula-generated patient specific rules to the medical information of the released patient, and

send a message to a health care professional based on the evaluated conditions of the released patient, wherein the message prompts the health care professional to determine

whether to readmit the released patient to the intensive care unit in response to the evaluated conditions indicating the patient is in the first recovery stage or

whether to discontinue continuously monitoring the released patient in response to the evaluated conditions indicating the patient is in the second recovery stage that needs periodic routine examination without continuous monitoring.

22. The system of claim **21** wherein the medical information is obtained by monitoring the released patient using a clinical medical device.

23. The system of claim **21** wherein the medical information comprises information about a location of the released patient determined by an electronic device.

24. The system of claim **23** wherein the electronic device is integrated with a device collecting the medical information of the released patient at the location.

25. The system of claim **23** wherein the electronic device comprises a portable electronic device.

26. The system of claim **21** wherein the memory comprises a centralized data repository for storing the medical information of the released patient and the computer provides users at the intensive care unit with access to the centralized data repository.

27. The system of claim **26** wherein the computer authenticates a user when the user requests to access the centralized data repository.

28. The system of claim **26** wherein the engine is configured to update the medical information of the released patient in the centralized data repository and the one or more rules in connection with the medical information.

29. The system of claim **21** wherein the engine is configured to provide computer-generated treatment recommendations to at least one of a location of the released patient and the intensive care unit.

30. The system of claim **21** wherein the engine is configured to display the conditions of the released patient in the intensive care unit continuously.

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